

# INDUSTRIAL VEHICLE HAVING BODY STRUCTURE

## BACKGROUND OF THE INVENTION

5           The present invention relates to an industrial vehicle having a body structure with a counterweight such as a counterbalanced forklift.

10           The counterbalanced forklift disclosed in, for example, Japanese Laid-Open Patent No. 2000-6624 has a body structure as described below. That is, a rear wheel axle supporting a pair of left and right rear wheels is pivotably supported in a vertical direction with respect to a vehicle body, and a lock cylinder regulating pivoting of the rear wheel axle is  
15 supported between a body frame and the rear wheel axle.

20           Generally, the body frame for the forklift is formed by welding a plurality of plate members. The counterbalanced forklift is provided with voluminous counterweight in the rear of the vehicle body. The rear end of the vehicle frame extends substantially to a position of the rear wheel axle. In the rear of the vehicle body toward the rear of the rear wheel axle, there is arranged a counterweight to be fixed to the rear end of the vehicle frame.

25           FIGS. 7 to 9 show the body frame 80 of the forklift described in the above-described publication. The body frame 80 has a pair of structures 81a and 81b coupled by a front coupling member 82 and a rear coupling member 83. A first  
30 back plate 84 couples rear portions of both structures 81a, 81b with each other. The first back plate 84 is arranged on a plane perpendicular to the fore-and-aft direction of the vehicle.

35           Each structure 81a, 81b has an extension portion

extending toward the rear of the vehicle body. Both extension portions are coupled to each other with a second back plate 85 arranged in parallel with the first back plate 84. Each extension portion is provided with a hanger portion 86 for  
5 detachably supporting the counterweight.

The body frame 80 is provided with an axle supporting portion 87 for supporting the rear wheel axle. The axle supporting portion 87 extends from the rear surface of the  
10 first back plate 84 toward the rear, and is coupled with the rear surface of the first back plate 84 and the lower end of the second back plate 85 (see FIG. 8).

Weight of the counterweight supported by both hanger  
15 portions 86 is applied to the axle supporting portion 87 via the second back plate 85, and further is applied to both rear wheels from the rear wheel axle supported by the axle supporting portion 87.

20 As shown in FIG. 9, the body frame 80 has a coupling portion 90 for supporting the lock cylinder 89. The lock cylinder 89 is provided between the coupling portion 90 and the rear wheel axle 88. The coupling portion 90 includes the second back plate 85, an installation plate 91 provided in the  
25 rear thereof, and a coupling shaft 92 for supporting the upper end portion of the lock cylinder 89. The lock cylinder 89 is supported by the coupling shaft 92 in the fore-and-aft direction of the vehicle.

30 For example, when the vehicle abruptly turns, an expansion/contraction operation of the lock cylinder 89 is inhibited, and as a result, pivoting of the rear wheel axle 88 with respect to the body frame 80 is inhibited, and any inclined movement of the vehicle is limited. Since a powerful  
35 force is applied to the coupling portion 90 from the lock



The counterweight forms a rear portion of the vehicle body. The counter weight supports the rear axle. The coupling portion is integrally formed with the counterweight to couple the fluid pressure cylinder with the vehicle body.

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Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

FIG. 1 is a schematic perspective view showing body structure of a forklift according to one embodiment embodying the present invention;

FIG. 2 is a schematic side view showing the forklift;

FIG. 3 is a schematic perspective view showing a body structure;

FIG. 4 is a schematic side view showing a supporting portion;

FIG. 5 is a schematic front view showing the supporting portion;

FIG. 6 is a schematic perspective view showing a cover and a counterweight;

FIG. 7 is a schematic plan view showing a prior art body frame;

FIG. 8 is a schematic side view showing the prior art body frame; and

FIG. 9 is a schematic partial sectional view showing a rear portion of the body frame.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, with reference to FIGS. 1 to 6, the  
5 description will be provided of an embodiment according to the  
present invention.

As shown in FIG. 2, an industrial vehicle, which is a  
counterbalanced forklift 10, has a pair of front wheels 12  
10 (only one of which is shown) in the front part of the vehicle  
body 11, and a pair of rear wheels 13 (only one of which is  
shown) in the rear part of the vehicle body 11. Both front  
wheels 12 are fixed driving wheels while both rear wheels 13  
are steered and driven wheels. The forklift 10 has a mast  
15 device 14 on the front side of the vehicle body 11, and has a  
cabin 15 between both front wheels 12 and both rear wheels 13.  
On top of the cabin 15, there is provided a head guard 16.

As shown in FIGS. 1 and 3, the vehicle body 11 includes  
20 plate assembly 17 for constituting substantially the front  
part and the counterweight 18 for constituting substantially  
the rear part.

The plate assembly 17 is formed by welding a plurality  
25 of plate members. The plate assembly 17 supports the front  
wheel axle (not shown) for supporting the both front wheels 12.  
Within space to be partitioned by the plate assembly 17, there  
are mounted an engine, a fuel tank, hydraulic loading  
equipment, engine driving auxiliary equipment and the like  
30 which are not shown. The plate assembly 17 constitutes the  
lower part of the cabin 15, and supports the head guard 16.

The counterweight 18 is integrally cast, and is fixed to  
the plate assembly 17 by means of a plurality of bolts (not  
35 shown). A rear wheel axle 19 has a center pin (not shown),

and is supported by the counterweight 18 with the center pin as a center of rotation so as to be pivotable in the vertical direction. The center pin is supported by a supporting portion (not shown) integrally provided with the counterweight 18, or a supporting member (not shown) made of a separate member, cast in the counterweight 18.

Between the counterweight 18 and the rear wheel axle 19, there is provided a lock cylinder 20. In the present embodiment, the lock cylinder 20 is a double-acting type fluid pressure cylinder. A shaft, which is a cylindrical portion 21 in this embodiment, is provided at the upper end of the lock cylinder 20. The cylindrical portion 21 is pivotably coupled with a pair of supporting portions 22a and 22b integrally provided with the counterweight 18. On the other hand, the lower end portion of the lock cylinder 20 is pivotably coupled with a supporting portion 19a provided at the rear wheel axle 19. A solenoid valve (not shown) selectively permits or inhibits supply or discharge of hydraulic fluid to or from the lock cylinder 20. Control of the solenoid valve permits or inhibits the rotation of the lock cylinder 20 in both directions of the rear wheel axle 19 with respect to the vehicle body 11. In the present embodiment, both supporting portions 22a and 22b constitute the coupling portion.

As shown in FIGS. 1 and 4, both supporting portions 22a and 22b are provided on an upper surface 23a for partitioning an accommodation recess 23 provided above the counterweight 18. Both supporting portions 22a and 22b are vertically installed so as to stand side by side in the fore-and-aft direction of the vehicle. The accommodation recess 23 accommodates lower parts of a radiator and a muffler (not shown) which are engine driving auxiliary equipment.

A through-hole 24 extends through the counterweight 18

in the vertical direction, and is opened on the above-described upper surface 23a. Both supporting portions 22a and 22b are provided in positions to oppose so as to sandwich the through-hole 24 therebetween. The upper end portion of the lock cylinder 20 extends through the interior of the through-hole 24.

As shown in FIGS. 4 and 5, each supporting portion 22a, 22b is shaped substantially like a plate having thickness in the fore-and-aft direction of the vehicle and length in the widthwise direction thereof. Also, a proximal portion of each supporting portion 22a, 22b has a curved portion 30 that widens toward an end such that each supporting portion 22a, 22b is smoothly connected to the counterweight 18. The curved portion 30 makes flowing of molten metal excellent during casting of the counterweight 18, and also functions to restrain stress concentration at the proximal end portion of each supporting portion 22a, 22b to the utmost for increasing the structural strength as much as possible.

In the both supporting portions 22a and 22b, there is supported a coupling shaft 25 for supporting the lock cylinder 20 in a state of extending in the fore-and-aft direction of the vehicle. The coupling shaft 25 is inserted through the cylindrical portion 21 of the lock cylinder 20 which is inserted through the through-hole 24 and is arranged between both supporting portions 22a and 22b. The coupling shaft 25 pivotably supports the lock cylinder 20 within a plane substantially perpendicular to the fore-and-aft direction of the vehicle.

As shown in FIG. 6, above the counterweight 18, there is provided a cover 26 which covers the accommodation recess 23 from the outside and constitutes an upper side of the rear part of the vehicle body 11. The cover 26 covers the

substantially entire upper side of the counterweight 18. The cover 26 covers the accommodation recess 23, whereby both supporting portions 22a and 22b are protected from the outside. Also, the cover 26 protects the radiator and muffler from the outside which are arranged within the accommodation recess 23 and are not shown.

The cover 26 is coupled with, for example, the rear part of the cabin 15 by means of a hinge (not shown). The cover 26 is rotated with the hinge as a center of rotation so as to spring up on the front side of the vehicle from a state in which the accommodation recess 23 is covered to enter a state in which the interior of the accommodation recess 23 is not covered. In the state in which the accommodation recess 23 is not covered with the cover 26, it is possible to inspect and maintain the cylindrical portion 21 of the lock cylinder 20, both supporting portions 22a and 22b and the coupling shaft 25 which have been exposed to the outside.

The present embodiment that has been described above in detail has each of the following advantages.

(1) The rear part of the vehicle body 11 is formed by the counterweight 18, and the rear wheel axle 19 and the lock cylinder 20 are supported by the counterweight 18. The lock cylinder 20 is coupled with both supporting portions 22a and 22b which have been integrally formed with the integrally-cast counterweight 18 having high rigidity.

Therefore, unlike the prior art body frame 80 shown in FIGS. 7 to 9, there is no need for plate members and reinforcement which form the coupling portion 90 for coupling the lock cylinder 89, but an assembly operation for welding these plate members and reinforcement to the body frame 80 is unnecessary.



As a result, since it is possible to eliminate welding points for providing the coupling portion and to simplify the body structure, the durability of the vehicle body 11 will be improved. Also, since the number of components and the manufacturing steps can be reduced, for example, the manufacturing cost can be reduced.

(2) Both supporting portions 22a and 22b are provided so as to be exposed in an upper part of the counterweight 18. For this reason, even when, for example, lubricating oil is replenished to the coupling shaft 25 supported by both supporting portions 22a and 22b, and between the cylindrical portion 21 of the lock cylinder 20 and the coupling shaft 25, there is no need for the removal of the counterweight from the body frame unlike the conventional body structure. Therefore, it becomes easier to maintain and inspect the coupling portion between the counterweight 18 and the lock cylinder 20.

(3) There is provided the cover 26 for covering both supporting portions 22a and 22b and constituting the upper side of the rear part of the vehicle body 11. For this reason, while protecting the coupling portion between the counterweight 18 and the lock cylinder 20 from external environment, it is possible to maintain and inspect the coupling portion only by removing the cover 26.

(4) The pair of supporting portions 22a and 22b have the curved portion 30, respectively. For this reason, stress concentration at the proximal end portion of each supporting portion 22a, 22b is restrained so that the structural strength is further increased to improve the durability of the vehicle body 11. Moreover, flowing of molten metal to each supporting portion 22a, 22b is made excellent during casting of the counterweight 18.

(5) Above the counterweight 18, there is provided the cover 26 for covering the accommodation recess 23 and constituting the upper side of the rear part of the vehicle body 11. Therefore, since the upper side of the rear part of the vehicle body which has conventionally been formed by the counterweight can be formed by the cover 26 made of synthetic resin or metal, putty finishing on the counterweight becomes unnecessary.

Next, the above-described embodiment may be modified as described below.

In place of the lock cylinder 20 as the fluid pressure cylinder, there may be used a damper for restraining a pivoting velocity of the rear wheel axle 19 with respect to the vehicle body 11.

In place of the double-acting type lock cylinder 20 for regulating rotation of the rear wheel axle with respect to the vehicle body in both directions, there may be provided a pair of single-acting type lock cylinder for regulating rotation to one or the other, respectively.

The structure may be arranged such that the coupling portion between the lock cylinder 20 and the counterweight 18 is not exposed above the counterweight 18. In this case, the cover 26 covers only the radiator and the muffler.

In place of the engine type counterbalanced forklift, a battery type may be adopted. In this case, in the accommodation recess 23 of the counterweight 18, there is arranged a controller for controlling a motor for running and a motor for loading and unloading.

The present invention may be applied to not only the counterbalanced forklift, but also a counterbalanced industrial vehicle having working attachments other than forks, such as for example, clamp, push-pull, ram and crane , and  
5 having a lock cylinder for regulating pivoting of the rear wheel axle for pivotably supporting.

The present invention may be applied to a shovel loader equipped with a counter weight.

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The present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the  
15 appended claims.